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notable helper, and we, his acquaintances and admirers, a loyal friend and the best of men."

Acknowledgement is made of the use of P. Walden's biography, *Ber. d. deutsch. chem. Ges.*, 41, 4719 (1908) and of W. A. Tilden's Memorial Lecture, *Jour. Chem. Soc.*, 95², 2077 (1909). These papers contained material otherwise inaccessible.

GEORGE SHANNON FORBES.

SIR JOHN MURRAY (1841-1914)

Foreign Honorary Member in Class II, Section 1, 1900.

Sir John Murray, the son of Scotch settlers in Canada, was born at Coburg, Ontario, on March 3d, 1841. There he passed the first seventeen years of his life. In the primitive conditions of a new community the natural robustness of his nature found a free development in congenial soil.

In 1858 he came to Edinburgh where he prepared for its University at the Stirling High School. His career at the University appears to have been stamped by some of the qualities that distinguished him in after life. Impatient of dogmatic authority, he was somewhat scornful of inherited tradition, and treated his prescribed studies with a cheerful *sans gêne*. For even in those days he desired to find out things for himself, and delve for knowledge independently. The capacity of clear and original thought, with a genius of disentangling the heart of a subject from its enveloping details, was as characteristic of the youth as of the man. From the small circle of scientific men who then made Edinburgh famous, he gathered, during his student days, what was most worth having, and went his way. That one of the facets of his personality drew him into a friendship with Louis Stevenson, offers a suggestive glimpse into a by-way of his character.

After continuing his scientific training for a period of several years at Bridge of Allen; he undertook a hazardous voyage to Spitzbergen, in a Peterhead whaler in 1868, to study the Arctic Sea. This was the initial exploit that marked him as a pioneer in Oceanography. With the history of the development of this science his

name is inextricably bound as a recognized leader. The work of Pourtalès, in 1867–1869, off the Florida coast in the *Corwin* and *Bibb*, had stimulated among scientific men the interest in deep sea exploration. This was further aroused by several English expeditions under the joint charge of Thomson, Carpenter and Jeffreys.

When, in December, 1872, the *Challenger* set out on her famous voyage, under the leadership of Sir Wyville Thomson, to explore the oceans of the world, Murray was appointed one of the three principal assistants. On the return of the *Challenger* from her cruise of nearly four years, he was made chief assistant in the colossal labor of publishing the Reports of the expedition. At the death of Sir Wyville Thomson in 1882, it was freely predicted that the work would never be finished. But Murray was appointed editor, rose superior to all obstacles and vicissitudes, and finally brought the enterprise to a successful conclusion by issuing the last of the fifty volumes in 1895.

He will probably be best remembered by his work in connection with the *Challenger Expedition*. The labor of editing the Reports was one of which the difficulty has perhaps not been fully realized. It could never have been completed without first class powers of organization and great determination of purpose. And it required skill and tact of the highest order to keep in hand the small army of specialists who were working on the reports in every quarter of the globe. Not the least of his troubles were his constant struggles to extract money from a grudging Treasury, that felt its patience sorely tried by the length and expense of the undertaking. At one stage of the proceedings Murray forced the Government to produce the necessary funds by threatening to finish the work at his own personal expense.

Murray used to say that he was the only man who had read every word of all the volumes. To carefully read all the page proof was in itself no light task.

With the assistance of Renard of the University of Ghent, he himself studied the deep sea deposits collected by the expedition. The result of this work was published as one of the volumes of the Report. This gave to science the first minute description of the deposits on the bed of the ocean, and disclosed the extreme slowness with which some of them are accumulating.

His active mind gave him a wide sympathy for many scientific activities. Among the several fields in which his services to science were important, should be mentioned his bathymetrical survey of the fresh-water locks of Scotland. This work he conducted for many years with a capable corps of observers. These investigations were

published in a series of six volumes, finished in 1910. This is probably the most complete work of its kind in existence.

Chiefly for the purpose of testing in deep water various new apparatus which had lately been used in shallow seas, Murray organized an oceanographic expedition to the North Atlantic in 1910, under the auspices of the Norwegian Government. He financed this enterprise himself, with the exception of the salaries of the government assistants, who were in charge of Dr. Johan Hjort. In his capacity of promoter and advisor of the cruise, Murray was cooped up and tossed about for several months, when nearly seventy, in the uncomfortable little steamer *Michael Sars*; a hardship that he made light of, for he loved the ocean which he knew so well.

In 1912 Murray and Dr. Hjort collected the results of the voyage in a volume entitled "*The Depths of the Ocean*." This publication, a valuable reference-book on thalassography, contains a complete summary of oceanography, it treats of the apparatus, the manner of its use and the ends reached in this science; while it brings the whole subject up to date with a description of the work accomplished by the *Michael Sars*.

To commemorate the memory of a close friendship, Murray gave a fund to the National Academy at Washington, establishing the Alexander Agassiz Medal, which is to be awarded occasionally for distinguished work in Oceanography. On the occurrence of its first award in 1913, the Academy adopted the following course. They selected Dr. Hjort for the honor, and sent a replica of the Medal to Murray.

It is hoped that at the end of the present war, a similar tribute can be offered through The Royal Society, which will establish a Sir John Murray Medal.

The Zoölogical stations on the Firth of Forth and on the Firth of Clyde were founded by him. It was in part due to his efforts that the meteorological observatory on Ben Nevis was created.

He took a keen interest in Polar Exploration, and made a journey to Norway for the express purpose of seeing Nansen start on his attempt to reach the North Pole. He first suggested the idea that the land around the South Pole is one continuous continent, which the explorations of Scott and Amundsen have done much to substantiate. The stimulus that Antarctic research received from Murray's enthusiastic support, was a powerful factor in materializing at least one of those expeditions.

Murray was the authority on deep sea deposits. Many of the

numerous explorers who, since the days of the Challenger, have probed the depths of the ocean, placed their collections of muds and slimes at his disposal for study and description. His familiarity with this subject led him to think there are no rocks on continental areas that could have been formed from such deposits as the red clays, the pteropod and the Globigerina oozes, which cover vast areas of the ocean's floor, where they have been accumulating for long periods of geological time. This led him to the firm belief that the ocean basins have remained fixed since the early ages of geology, and to a disbelief in those lost Atlantes and elevated pathways called on to explain the geographical distribution of land flora and fauna. Nor did he admit that Australia, India, Africa, South America and Antarctica had ever formed a single continent.

Murray very naturally considered that the pendulum and geodetic observations of late years, as well as measurements of gravity over the ocean, attest the permanence of the ocean basins. "For," as he wrote to a friend not long before his death, "it is extremely improbable that there could be such a shifting of materials in the deeper parts of the crust as to cause sub-oceanic heaviness to give place to sub-continental lightness — such as now is found to exist."

He insisted that abyssal Radiolarian ooze was a different deposit from those that have formed Radiolarian rocks. Although Molen-graaff, in his recent papers on the Danau formation, dissents from this view, he believes in the permanence of continents and ocean basins. For he considers that the theory is supported by the rarity of the Radiolarites, and the fact of their being limited to the geosynclinals; that is to the more mobile portions of the earth's crust, which in broader or narrower strips separate the great stable areas.

In common with most naturalists who since Dana's day have examined coral reefs in the field, Murray returned from the voyage of the Challenger convinced that Darwin's theory of subsidence did not satisfactorily explain the formation of coral atolls and barrier reefs. Murray's theory lays special stress on the building up of marine platforms, by the gradual deposit of the remains of marine organisms, to a suitable height for the growth of reef building corals; and to the seaward growth of corals on the talus, broken from the living reef and rolled down its outer slope. The formation of the lagoons of atolls and the passages between barrier reefs and the land he attributed to the solvent action of sea water.

When Murray, then a comparatively young man, first suggested his theory, he was advised not to publish anything hastily. This

delayed its appearance for about two years. The Duke of Argyll, learning of this fact, wrote accusing the scientific world of a deliberate attempt to suppress the truth for fear of injuring the prestige of Darwin. This called forth the indignant protest of Huxley. The controversy, which created a considerable commotion among the scientific men of that day, was known as the "Conspiracy of Silence."

Murray maintained that the famous coral boring on the Atoll of Funafuti in the Ellice Islands, made under the auspices of the Royal Society of London, supported his views. In fact he predicted that the diamond drill would penetrate into a talus. It might have been inferred from this prophecy that the core taken from Funafuti would lead to a discussion of what it actually revealed. A site for the hole should have been selected where, if, as many believe, the theory of subsidence is mistaken, the drill would have encountered only a comparatively thin stratum of coral rock. Such a site might be found at some point a short distance from the centre of a lagoon, but even there the evidence would not be conclusive if the atoll happened to rest on a foundation of limestone. The situation chosen for the Funafuti bore, on the rim of a large atoll, was unfortunate, and the work instead of proving anything has complicated the subject; for eminent men have drawn very different conclusions from the results of the undertaking. Distinguished supporters of Darwin's theory of subsidence have held that the drill pierced a continuous coral reef. Murray believed it "passed through a portion of the talus produced by the fragments torn from the growing face of the reef, and on which it had proceeded seawards." While Alexander Agassiz was inclined to think that the drill passed in part through Tertiary limestones, and in part through a talus of modern material.

The theories of Murray, Agassiz, and Gardiner differ in the amount of work that they attribute to modern corals, and the relative values they assign to such agencies as organic deposits, erosion, solution, the trade winds, and the scouring force of the ocean. But they all agree in asserting that Darwin's theory of subsidence does not offer a satisfactory solution of the method of formation of atolls and barrier reefs.

One episode in Murray's life furnishes a good example of the unexpected practical benefits that may result from the pursuit of pure science. While cruising in the regions adjacent to the island of Java, the nets of the Challenger collected some bits of phosphate. A careful examination of these objects convinced Murray that they must have been formed on land. Subsequent search for their origin, under Murray's auspices, led to the discovery of the phosphate deposits of

Christmas Island. The island was annexed to Great Britain, and a company under Murray's presidency developed a highly prosperous mine. Some years before his death the company had already paid in royalties, for the protection of the English flag, more than the entire cost of the Challenger expedition!

This enterprise made Murray rich, and while he accepted the opportunities which the possession of wealth offers to an intelligent man, it in no way affected his interest in the pursuit of science. One of the chief projects of his last years was to equip a vessel on the lines of the Prince of Monaco's "Princesse Alice," and set out in her for a protracted cruise around the world in the interest of oceanography.

Murray was elected a Foreign Honorary Member of the American Academy in 1900. Among the many other honors that came to him in recognition of his scientific work, he received the Prussian order 'Pour le Mérite. Punch celebrated the event with a cartoon, which always delighted Murray. As the final decision in the award rests with the King of Prussia, the picture represents the Kaiser who has called for the publications of the candidate. Vistas of lackeys are staggering in loaded with the mighty volumes of the Challenger Report, while the astonished monarch asks in amazement why the name of this prolific author had not been previously suggested.

Under a somewhat brusque manner, Murray could not conceal a genial kindness, and deep human sympathy and interest. His devotion to research was combined with a strength of will and a steadfastness of purpose, that rendered him singularly efficient in anything he undertook, whether scientific or practical; for he had an unusually clear and steady vision in worldly affairs, uncommon in the devotee of pure science.

His connection with the Challenger Reports began a wide acquaintance among scientific men; his business interests in Christmas Island, Canada, and the United States threw him in broad touch with a different world. Accustomed to meet many varieties of people, the readiness with which his keen and active mind struck fire in contact with other men, made him, wherever he went, a commanding figure.

Murray had little sympathy for those whom he termed the hod carriers of science. Men whose mental activities seem to be satisfied in collecting undigested facts. Not that he undervalued facts, but that he strove to fit them into the body of human knowledge. He never lost sight of the aim of science, a deeper insight into Nature, and a broader outlook on the Universe.

In 1889 Murray married Isabel Henderson, daughter of Thomas

Henderson the shipowner, and brought his wife back to Edinburgh, where their home became one of its intellectual centres. For many years of his later life, Sir John and Lady Murray, with their family of two boys and three girls, lived in a roomy house on the outskirts of Edinburgh, which he had christened "Challenger Lodge." It was characteristic of the man that his unfailing insight enabled him to establish a most sympathetic relation with his children, and caused him to use original methods, based on great independence and liberty, to develop them into efficient and self reliant personalities.

Turning into his own avenue, on March 16, 1914, Murray's automobile skidded and capsized, killing him instantly. Such an end, always wished for by him, came as a shock to his friends in many lands, whose admiration for the naturalist was only exceeded by their love of a very human fellow-man.

G. R. AGASSIZ.

ANDREW HOWLAND RUSSELL (1846-1915)

Fellow in Class I, Section 4, 1892.

Andrew Howland Russell was born in Plymouth, Massachusetts, on the 24th of December, 1846. His father, Andrew Leach Russell, and his mother, Hannah White Davis, were both of the old Pilgrim stock. He was educated first in the public schools of Plymouth, then spend two or three years at Philips Exeter Academy. In 1865 he was one of the first class to enter the Massachusetts Institute of Technology, but did not complete the course because in 1867 he received an appointment to the Military Academy from which he was graduated fourth in his class in 1871.

He was then promoted to Second Lieutenant in the Third Cavalry, in 1876 to First Lieutenant of Ordnance, in 1888 to Captain, 1901 to Major, 1895 to Lieutenant Colonel, 1907 to Colonel. From July to November, 1898, he held a Volunteer Commission as Major and Chief Ordnance Officer; from 1901 to 1904, he was Chief Ordnance Officer of the Division of the Philippines with the rank of Lieutenant Colonel.

As a Cavalry Officer, in 1871-1872, he served with his regiment in Arizona and Nebraska; in 1873-1874 on the Wheeler Expedition for Surveys west of the 100th Meridian, in New Mexico, Colorado and